UNITED STATES
DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE
OFFICE OF LAND AND WATER RIGHTS
WATER RIGHTS SECTION
SAN FRANCISCO, CALIFORNIA

HYDROLOGIC INVESTIGATION OF UPPER AND LOWER EMIGRANT SPRINGS

AT

DEATH VALLEY NATIONAL MONUMENT, CALIFORNIA

By

Gerard S. Witucki

Administrative report
for U.S. Government use only

February, 1968

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I - INTRODUCTION

The need exists for an increased water supply for the Emigrant District at Death Valley National Monument (Morris, 1966). This situation is further complicated by the existing water right of 700 gallons per day at Lower Emigrant Springs by the Stove Pipe Wells Hotel organization (General Hotel Company). It appears likely that the owners of the facilities at Stove Pipe Wells Hotel may wish to expand their facilities and hence increase their need for water. The organization has unsuccessfully attempted to drill a potable water well closer to their facilities.

Geological Survey Hydrologist F. F. Zdenek (1966) prepared a report for the National Park Service which described a number of small springs which he felt could be put together to make up the above-mentioned water supply. It was felt that the best potential sources would be the Upper and Lower Emigrant Springs. This report presents the results of an investigation made as an aid in the determination of what further steps can be taken to increase the amount of captured water at Upper and Lower Emigrant Springs (see Fig. 1).


DEATH
VALLEY
NATL.
MONUMENT
Beatty
Rhyolite
Wahguyhe Pk.
Mc Donald Spr.
Cave Rock Spr.
Leadfield
Thimble Pk.
Lostman Spr.
DAYLIGHT PASS
Boundary Can.
Keane Spr.
Hole In The Rock Spr.
Death Valley Buttes
HELLS GATE
Chloride City
Chloride Cliff
Monarch C.
Midway Well
Triangle Spring
MESQUITE FLAT
Stovepipe Wells
Sand Dunes
SAND DUNE JCT.
DEVILS CORN FIELD
Stove Pipe Wells Hotel
BEATTY JCT.
Salt Spr.
Sulphur Spr.
Salt Spr.
Emigrant Wash
Black Point
RANGER STATION
EMIGRANT JCT.
TUCKI MOUNTAIN
Telephone Spr.
Emigrant Spring
SITE OF SKIDOO
BOOT HILL CEM.
Upper Emigrant Spr.
SKIDOO MINE
Burro Spr.
Pinto Pk.
TOWNES PASS
Panamint Butte
Blackwater Spr.
AGUERREBERRY CAMP
AGUERREBERRY PT.
SITE OF HARRISBURG
EMIGRANT PASS
White Sage Flat
Wood Canyon
Wildrose Pk.
Wildrose Station
Mud Spr.
Tucki Wash
NATIONAL MONUMENT HDQRS
VISITOR CENTER
Furnace Creek Ranch
Furnace Creek Inn
Travertine Sprs.
Zabriskie Point
20 MULE TEAM CANYON
ARTISTS PALETTE
Salt Spring
Winters Pk.
Nevares Pk.
INDIAN PASS
SITE OF LEE'S CAMP MINES
SITE OF LEELAND
Big Dune
Amargosa River
SITE OF SCRANTON
Pyramid Pk.
Ryan
DEVILS GOLF COURSE
Natural Bridge
Mt. Perry
Salt Pools
BENNETTS LONG CAMP
LOWEST ELEVATION IN U. S. 282 FEET BELOW SEA LEVEL
Tule Spring
Badwater
Shorty's Well
CHARCOAL KILNS
THORNDIKES CAMP
Rogers Pk.
Tuber Spr.
Bennett Peak
Telescope Peak
Hanaupah Can.
SHORTY'S GRAVE
SITE OF EAGLE BORAX WORKS
Bennetts Well
DANTES VIEW
Coffin Pk.
Funeral Pk.
CORONA MINE
Jail C.
INDIAN RANCH
Warm Sulphur Spring
THOMPSON CAMP
SITE OF PANAMINT CITY
Surprise Canyon
CHRIS WICHT CAMP
Sentinel Pk.
HUNGRY BILLS RANCH SITE
Starvation Can.
Johnson Canyon
Gravel Well
Ballarat
Happy Can.
Pleasant Can.
Porter Pk.
Six Spring Can.
Gold Hill
Salt Well
Middle Park Can.
SOUTH PARK
Arrastre Spr.
Galena Can.
TALC MINE
Warm Spr.
Striped Butte
Redlands C.
Manly Peak
Anvil Spring
Needle Pk.
Sugarloaf
MENGEL PASS
Cinder Hill
Shore Line Butte
Smith Mountain
Sheep C.
Mormon Pt.
Willow Crk.
Ashford
ASHFORD MILL
Jubilee Mtn.
Epaulet Peak
Salsberry Peak
Ibex Pk.
CONFIDENCE HILLS
PANAMINT
COTTONWOOD MOUNTAINS
Marble Can.
Cottonwood Can.
Cottonwood Spr.
Lemoigne Can.
Jayhawker Can.
Nemo C.
GREENWATER
FUNERAL MOUNTAINS
AMARGOSA DESERT
BLACK MOUNTAINS
GRAPEVINE MOUNTAINS
BULLFROG HILLS
BEATTY AIRPORT
Bare Pk.
BULLMOOSE MINE
SITE OF CARRARA
CRATER FLAT
Amargosa
Franklin Well
Kelleys Well
Rhodes Well
Bradbury Well
Virgin Spr.
Ashford Mine
SALSBERRY PASS
DEADMAN PASS
ASH HILL
STOCKWELL MINE
LIMESTONE QUARRY
Lotus Mine
Sourdough Spr.

FIGURE 1

II - PROCEDURES

After reviewing applicable reports, visiting the specific sites (see Fig. 2), and holding preliminary discussions with Superintendent J. Stratton and Chief of Maintenance T. Boothroyd, at Death Valley, the following collective recommendations were made (Witucki, 1967):

Upper Emigrant Springs

1. Drill or auger as many borings as practicable through the alluvium.
   A. Borings at this location may be somewhat troublesome due to the coarseness of the gravel (cobble and boulder sizes are common).
   B. Borings at this location should be done with mechanized equipment if at all possible.

Lower Emigrant Springs

1. Drill or auger as many borings as can be practicably accomplished. The gravels here do not contain as many large sizes.

Hopefully, the borings will contribute the following data:

1. Depth to bedrock; Configuration of the subsurface alluvium.
2. Depth to water; General configuration of the saturated portion of the aquifer.

3. Description of the material encountered - in that this information will be useful if an extensive infiltration gallery should be installed.

The following drilling methods were considered:

1. Mechanized augering (continuous flight).
2. Rotary drilling with air.
3. "Chicago Pneumatic" - This is similar to an air jack-hammer; miners often use this method. It produces a 2-inch diameter boring and is fairly portable.

The relief of the terrain about these springs, particularly at Lower Emigrant, varies sharply and was a factor as to the choice of equipment. It was decided to choose the equipment that would most nearly produce the desired data without an unreasonable amount of effort expended.

It had been intended to do some backhoeing. Unfortunately, at the time of the investigation, the equipment was not available. It had also been hoped to run a simple seismic survey at the Upper Emigrant site to verify the depth to bedrock as indicated by the augering; however, untimely equipment malfunction prevented this.

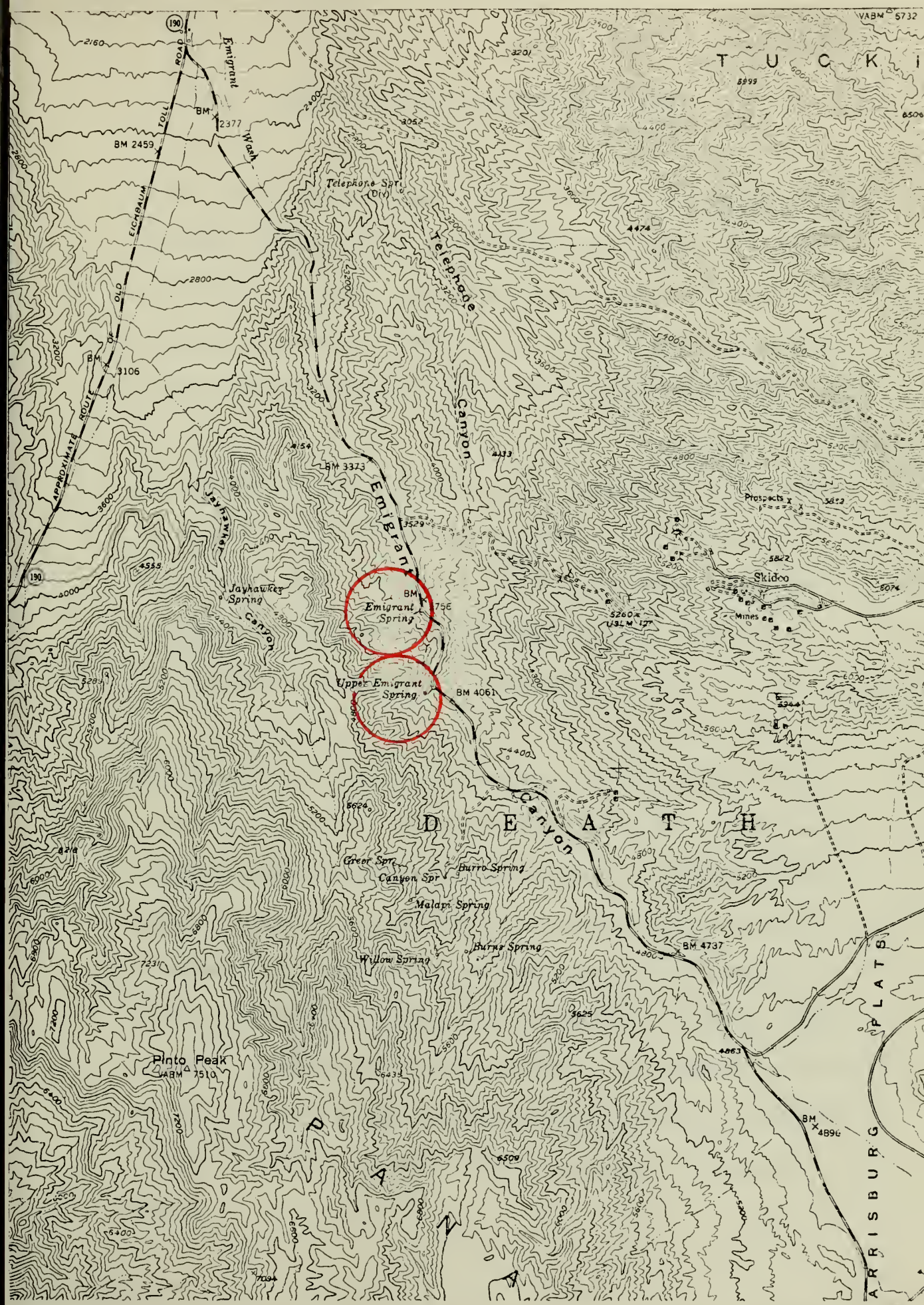

Emigrant Wash
TOLL ROAD
OLD EICHBAUM
APPROXIMATE ROUTE OF
BM 2377
BM 2459
BM 3106
Telephone Spr.
Telephone Canyon
BM 3373
Emigrant Canyon
Jayhawkers Spring
Emigrant Spring
Upper Emigrant Spring
BM 4061
Prospects
Skidoo
Mines
USLM 17
DEATH Canyon
Greer Spr.
Canyon Spr.
Burro Spring
Malapi Spring
Burro Spring
Willow Spring
BM 4737
Pinto Peak
VABM 7510
PANAMINT
TUCKI
VABM 5732
BM 4896
ARRISBURG FLATS

FIGURE 2

III - INVESTIGATION AT UPPER EMIGRANT SPRINGS

A four-inch mechanized auger (continued flight) was borrowed from the Naval Weapons Station at China Lake, California, as it was not possible to obtain satisfactory boring equipment from local drilling contractors. Three to four inches of snow fell on sites prior to the investigation, which began on December 18, 1967.

An arbitrary datum was selected at the intersection of the center of Emigrant Canyon Road and the projected axis of the canyon (assumed elevation of 0 feet). The 19 boring sites were located in relation to this selected datum (see Fig. 3). The logs of the borings are attached in the Appendix.

By examining the logs, it is seen that borings 1 - 6 vary from 2 to 5 feet in depth. Although boulders rather than bedrock were probably encountered in some of the borings, it appears that the alluvial cover is somewhat thin here. Borings 7 and 9 indicated a thickening of alluvium and the presence of water. Boring 8 seems to indicate the western edge of the aquifer. Boring 10 may indicate the bedrock of the eastern edge of the alluvium. Borings 12, 13, 14 and 15 to the north of the abandoned well all indicate moisture. Maximum depths of alluvium were found at borings 9 and 14.

Boring 16 drilled in an associated drainage, at what visually appeared to be the maximum depth of alluvium there, indicated alluvium to a depth of about four feet without any sign of moisture.

Borings 17, 18 and 19 drilled in the narrowest part of the canyon indicated a relatively shallow cover of alluvium which was saturated near the surface. Water generally runs on the surface near boring 19.

Upon completion of the borings, two-inch steel pipes (lower two feet perforated) were set in four selected borings: 9, 11, 12 and 13. Water measurements were made on the following day in these borings and also in the others, indicating moisture (see Table 1).

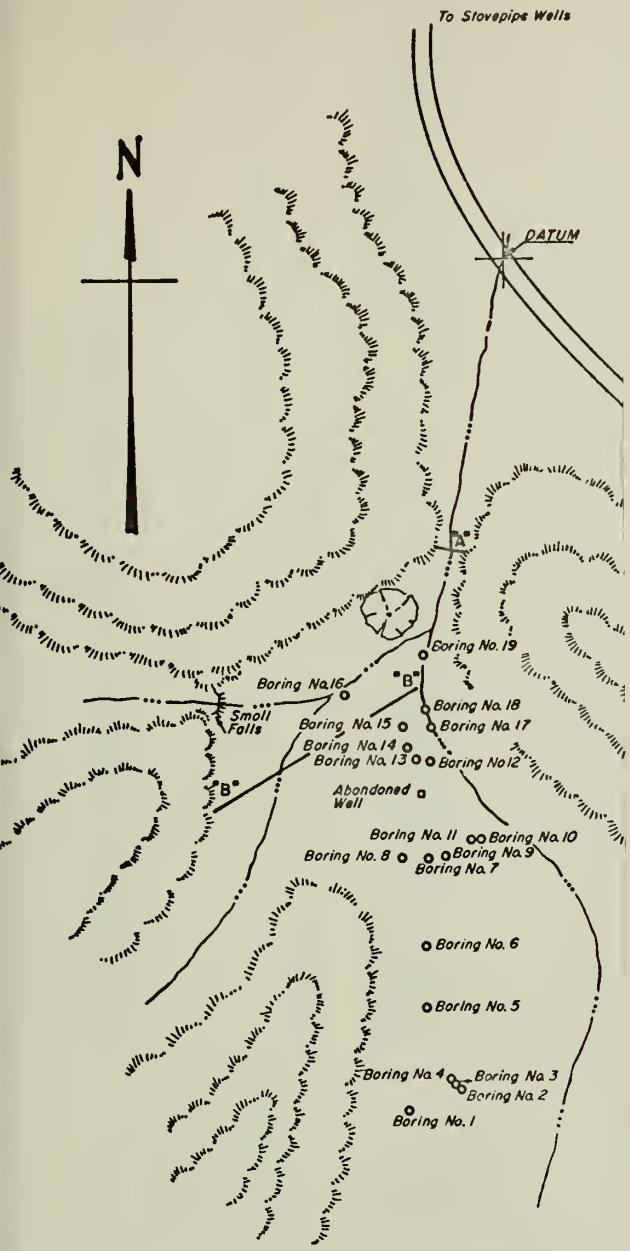
Conclusion and Recommendations

The boring logs reflect the general configuration of aquifer and its saturated portions. However, as pointed out, it had snowed 3 to 4 inches and the melting snow was presently contributing to the water table in the alluvium. It is felt that the borings generally indicate where the lower portions of alluvial covered bedrock occur. If required, a somewhat general isopachous map could be drawn based on the data, so as to reflect a general

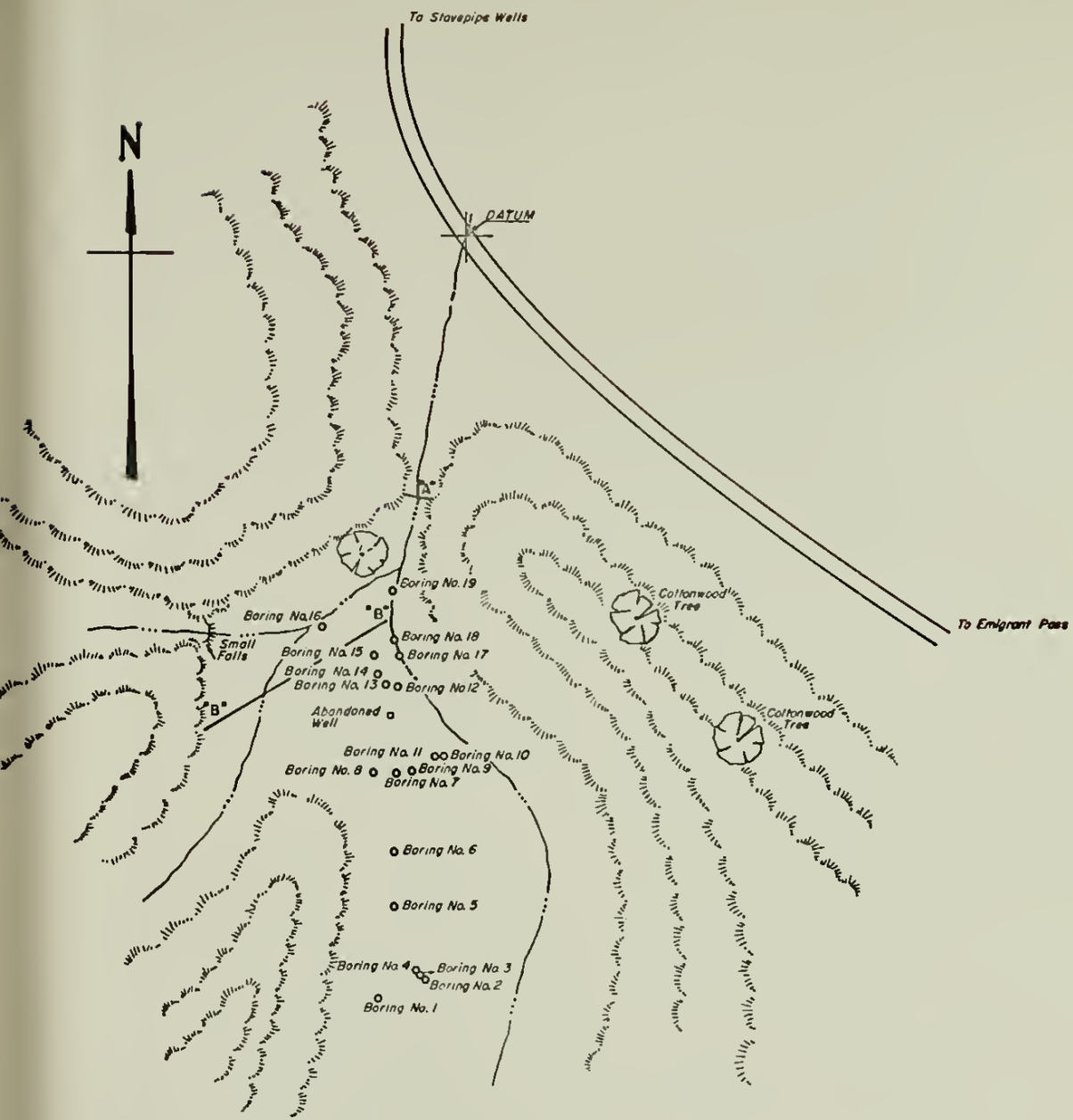
indication of aquifer storage. The depths to water reflected by this investigation in combination with a continuous sounding program of the four cased wells should give an indication of the fluctuations of the water table throughout the year as well as an indication of the hydraulic gradient.

It is suggested that an impermeable boundary be installed (i.e., cement keyed walls, grout, etc.) somewhere between the outcrops from A to B of Fig. 3, depending on the economics of the installation, so as to utilize the alluvial cover as subsurface storage. Although an impermeable barrier right at A would be more economical than anywhere from A to B, it may be possible to capture more water with a barrier toward B, as some water may be lost to underflow in the bedrock before it reaches A. Mr. Glen Miller of USGS plans to make some flow measurements at A and make some comparisons with the fluctuations of the water table reflected in the cased borings. This may give some general indication as to whether underflow is occuring.

It is suggested that a backhoe be used to investigate the alluvium prior to making a determination as to the best location of the impermeable barrier.



L. Sando, Feb. 9, 1968



Boring No. 1 - Elev. 109.0', Total depth 5', Dry
Boring No. 2 - Elev. 104.0', Total depth 5', Dry
Boring No. 3 - Elev. 104.0', Total depth 2', Dry
Boring No. 4 - Elev. 104.0', Total depth 2.5', Dry
Boring No. 5 - Elev. 97.0, Total depth 2', Dry
Boring No. 6 - Elev. 91.0', Total depth 5', Dry
Boring No. 7 - Elev. 74.0', Total depth 9.5', Signs of moisture at 6.5'
Boring No. 8 - Elev. 77.0', Total depth 5', Dry
Boring No. 9 - Elev. 73.0', Total depth 14', Cased 9' below surface, 2' of standing water before casing on Dec. 21.
Boring No. 10 - Elev. 73.0', Total depth 5', Dry
Boring No. 11 - Elev. 71.0', Total depth 7.5', cased 9.5' below surface, 2.5' of standing water after drilling on Dec. 20.
Boring No. 12 - Elev. 64.0', Total depth 4', Cased 3.5' below surface, 0.2' of standing water after drilling
Boring No. 13 - Elev 61.0', Total depth 7.0', Cased 7' below surface, 0.5' of standing water after drilling
Boring No. 14 - Elev. 60.0', Total depth 10', Signs of moisture at 7.5'
Boring No. 15 - Elev. 60.0', Total depth 7', Signs of moisture at 6'
Boring No. 16 - Elev. 59', Total depth 4', Dry
Boring No. 17 - Elev. 55', Total depth 4' Saturated at 1', 2' of standing water after drilling
Boring No. 18 - Elev. 54', Total depth 5', Saturated at 0.5', 1.5' of standing water at
Boring No. 19 - Elev. 45', Total depth 2', Saturated all the way down

HALF-SIZE REPRODUCTION

DATUM = 0' ELEV. (ASSUMED)
SCALE 1" = 100'

PLOT PLAN
Boring Locations - Upper Emigrant Springs
DEATH VALLEY NATIONAL MONUMENT

by L. Sando, Feb. 9, 1968

FIGURE 3

TABLE 1 - SOUNDINGS OF THE BORINGS INDICATING MOISTURE

Boring No.	Date	Total Depth at Date of Sounding	Depth to Water	Remarks
7	12/21/67	---	---	Boring was caved on the 21 of December.
* 9	12/21/67	14'	12	This sounding was taken prior to setting 9' of casing. No sounding was made after setting casing as water was not stable.
* 11	12/21/67	7.5'	5'	None.
* 12	12/21/67	3.5'	2	Boring caved 0.5' overnight.
* 13	12/21/67	7'	6'	None.
14	12/21/67	---	---	Boring was caved on 21 of December.
15	12/21/67	---	---	Boring was caved on 21 of December.
17	12/21/67	4'	2'	
18	12/21/67	3'	1.5'	
19	12/21/67	2'	Surface	Saturated from the surface down.

* Note - Cased Borings

IV - INVESTIGATION AT LOWER EMIGRANT SPRINGS

Because of the steep relief, it was not possible to use the mechanized auger here. Therefore, the pneumatic-type drill equipment provided by the Park's maintenance force was used. Zdenek, in his report (1966), discussed the possibility of the base of the aquifer being in the fractured bedrock underlying the alluvium at this site.

It was not possible to get up to the elevation where the present collection system is installed because of the length of the air hose in relation to position of the air compressor. Two boring sites were located in an eroded natural drainage channel above an old mine opening (see Fig. 4). Visually, it appeared that stratigraphically the sites were located at the contact of the alluvium with the bedrock (green felsitic igneous intrusive - probably a dike).

Similarly as at Upper Emigrant Springs, an arbitrary datum was selected at the intersection of the center of Emigrant Canyon Road and the projected axis of the canyon (assumed elevation of 0 feet). Boring sites were located in relation to this selected datum (see Fig. 4). The logs of the borings are attached in the Appendix.

Boring 1 met refusal at a depth of three feet, and the cuttings reflected weathered bedrock. Boring 2 had to be drilled at an approximately 45° angle with the ground surface to facilitate handling the equipment. Most of the boring was in weathered bedrock. Water which flowed was first encountered at $3\frac{1}{2}$ feet (slant depth).

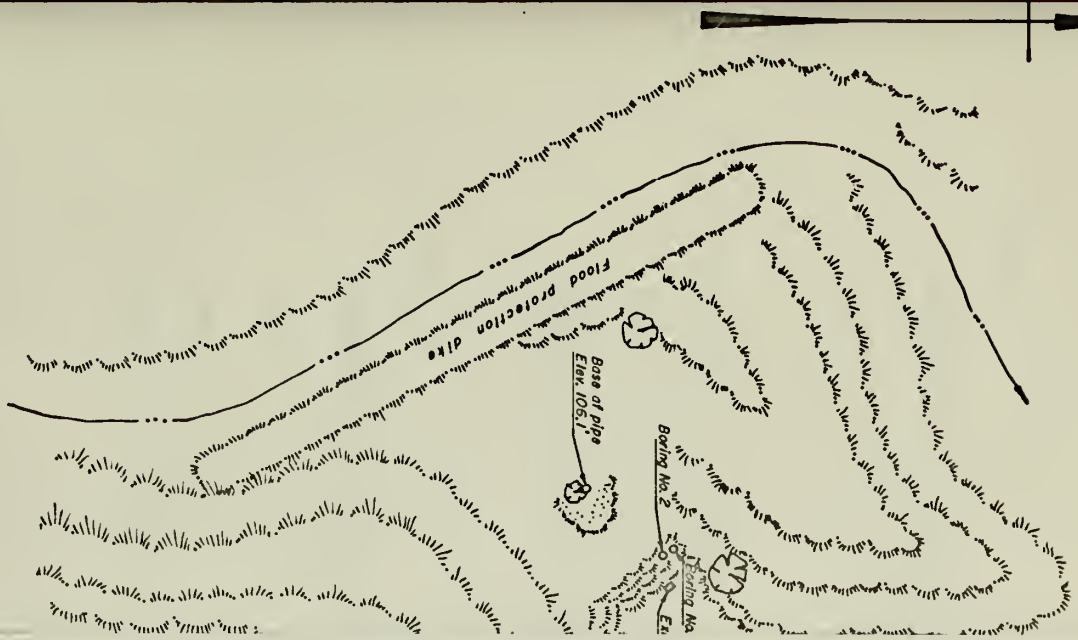
The drilling was halted for about an hour at approximately 4 feet (slant depth); the boring filled to a few inches from the top in this time. After resuming drilling, the boring met refusal at 9 feet (slant depth). Two small streams of water appeared to be flowing in the boring at 3.5 and 6' at approximately 1/10 GPM. At the end of four hours, the boring filled almost to the surfact but did not flow and appeared static.

Conclusion and Recommendations

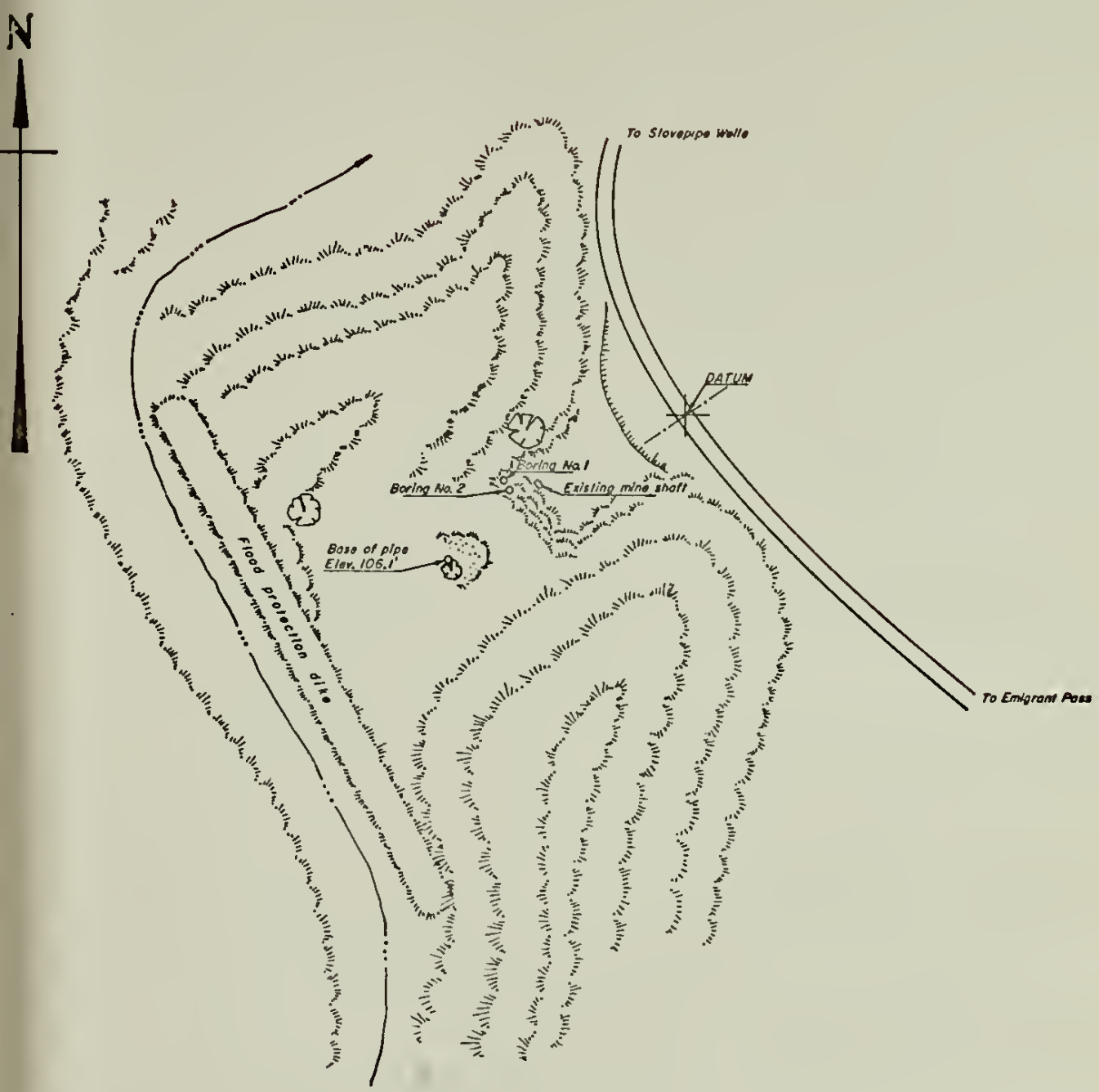
Boring 2 indicated that the water does occur in the fractured bedrock. So, in order for a collection system to be most effective at this site, it should be put into the bedrock.

In view of the apparent attitude of the igneous intrusive in relation to the alluvium and the older host rock, there may be water held back of the intrusion, possibly directly below the existing collection system. There may be some merit in obtaining

pneumatic equipment that could drill to the approximate depth of 100 feet, which could be utilized in drilling a horizontal boring located somewhat lower in elevation than boring 2. Hopefully, this boring would intercept any water held behind the intrusive in either or both the alluvium and the older intruded rock. If successful, this approach could be expanded and would eliminate the need for an expensive collective system in the bedrock.



L. Sondo, Feb 15, 1968



Boring No. 1 - Elev. 61.0', Total depth 3', Dry
Boring No. 2 - Elev. 61.0', Total slant depth 9', Water at 3.3' and 6'.

HALF-SIZE REPRODUCTION

DATUM = 0' ELEV. (ASSUMED)
SCALE 1" = 100'

PLOT PLAN
Boring Locations - Lower Emigrant Springs
DEATH VALLEY NATIONAL MONUMENT

FIGURE 4

y L. Sando, Feb. 15, 1968

REFERENCES CITED

Morris, M. - 1966

Memorandum to Assistant Director, Specialized Services (June 6, 1966), Stovepipe Wells.

Witucki, G. S. - 1967

Field Trip Report on Death Valley National Monument, Inclusive dates of travel: 11/27 - 11/29, 1967.

Zdenek, F. F. - 1966

Memorandum to Supervisor, Death Valley National Monument (February 18, 1966). Information - Examination of one proposed well-site and eleven potential spring developments in the Death Valley National Monument, California.

APPENDIX

LOCATION OF BORING

See Map Plat

Assume elev. of 0'
Axis of Canyon and
DATUM ℄ of Emigrant C. Rd. ELEVATION 109'

JOB NO.	CLIENT DV-NM	LOCATION Upper Emigrant Spr.
DRILLING METHOD: Auger - 4" diameter		BORING NO. 1
SAMPLING METHOD: Cuttings		SHEET 1 OF 1

WATER LEVEL					DRILLING START	DRILLING FINISH
TIME					TIME 11:30 A.M.	TIME 11:40 A.M.
DATE					DATE 12/20	DATE 12/20
CASING DEPTH						

SURFACE CONDITIONS: 3"-4" Snow on the ground

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO. / SAMPLE DEPTH	BLOWS/FT. SAMPLER	NUMBER OF RINGS	DEPTH IN FEET	SOIL GRAPH	
						0		
						1		
						2		Reddish gravel fine to coarse occasional boulder
						3		
						4		
						5		Met refusal either boulder or bedrock
						6		
						7		
						8		
						9		
						0		
						1		
						2		
						3		
						4		
						5		
						6		
						7		
						8		
						9		
						0		

DRILLING CONTR. Water Rights Sec. National Park Service, SSC

BY L. Bendo DATE 12-20-67 CHK'D BY G. Witucki

LOCATION OF BORING

See Map Plat

Assume elev. of 0' Axis of Canyon and ℄ of Emigrant C. R.

DATUM ℄ of Emigrant C. R. ELEVATION 104'

JOB NO.	CLIENT	LOCATION
	DV-NM	Upper Emigrant Spr.

DRILLING METHOD	BORE HOLE NO.
Auger - 4" diameter	2
SAMPLING METHOD	SHEET 1 OF 1
Cuttings	DRILLING START / FINISH

WATER LEVEL		
TIME		
DATE		
CASING DEPTH		
TIME START	11:00 A.M.	11:30 A.M.
DATE START	12/20	12/20

SURFACE CONDITIONS: 3"-4" Snow on the ground

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO / SAMPLE DEPTH	BLOWS/FT. HAMMER	NUMBER OF RUNS	DEPTH IN FEET	SOIL GRAPH
						0	
						1	
						2	
						3	
						4	
						5	
						6	
						7	
						8	
						9	
						0	
						1	
						2	
						3	
						4	
						5	
						6	
						7	
						8	
						9	
						0	

Reddish gravel fine to coarse occasional boulder

Gravel become more uniform, pea size

Met refusal at 5' hit boulder or bedrock

DRILLING CONTR. Water Rights Sec. National Park Service, SSC

BY J. Sanchez DATE 12-20-67 CHKD BY G. Witucki

A 2

DRILLING CONT. Water Rights, Sec. National Park Service, SSC

BY L. Sands DATE 12-20-61 CHKD BY G. Witucki

LOCATION OF BORING

See Map Plat

Assume elev. of 0'
Axis of Canyon and
DATUM E of Emigrant C. RELEVATION 104'

JOB NO.	CLIENT	LOCATION
	DV-NM	Upper Emigrant Spr.

DRILLING METHOD:	BORING NO.
Auger - 4" diameter	3
SAMPLING METHOD:	SHEET 1 OF 1
Cuttings	DRILLING START / FINISH

WATER LEVEL		TIME 11:00 A.M.	TIME 11:30 A.M.
TIME			
DATE		DATE 12/20	DATE 12/20
CASING DEPTH			

SURFACE CONDITIONS: 3"-4" Snow on the ground

SAMPLER TYPE	WATER LEVEL INCHES DRIVEN / RECOVERED	DEPTH OF CASING	SAMPLE NO. / SAMPLE DEPTH	BLOWS/FT. HAMMER	NATURE OF BIRCH	DEPTH IN FEET	SOIL GRAPH	
						0		Reddish gravel fine to coarse occasional boulder
						1		
						2		Met refusal at 2.5' hit boulder or bedrock
						3		
						4		
						5		
						6		
						7		
						8		
						9		
						10		
						11		
						12		
						13		
						14		
						15		
						16		
						17		
						18		
						19		
						20		

A 3

DRILLING CONTR. Water Rights Sec. National Park Service, SSC

LOCATION OF BORING

See Map Plat

Assume elev. of 0' Axis of Canyon and ℄ of Emigrant C. Rd.

DATUM | ELEVATION 104'

JOB NO.	CLIENT DV-NM	LOCATION Upper Emigrant Spr.

DRILLING METHOD: Auger - 4" diameter

BORING NO. 4

SHEET 1 OF 1

SAMPLING METHOD: Cuttings

DRILLING	
START	FINISH
TIME 11:00 A.M.	TIME 11:30 A.M.
DATE 12/20	DATE 12/20

WATER LEVEL				
TIME				
DATE				
CASING DEPTH				

SURFACE CONDITIONS: 3"-4" Snow on the ground

DEPTH IN FEET	DESCRIPTION
0	
1	Reddish gravel fine to coarse occasional boulder
2	
3	Met refusal at 2.5' hit boulder or bedrock

Columns: SAMPLER TYPE; INCHES DRIVEN / INCHES RECOVERED; DEPTH OF CASING; SAMPLE NO / SAMPLE DEPTH; BLOWS/FT. SAMPLER; NUMBER OF RINGS; DEPTH IN FEET; SOIL GRAPH

LOGGED BY ... DATE 12-20-61 CHECKED BY G. Mikitucki

LOCATION OF BORING

See Map Plat

Assume elev. of 0' Axis of Canyon and

DATUM ℄ of Emigrant C. Rd ELEVATION 97'

JOB NO.	CLIENT DV-NM	LOCATION Upper Emigrant Spr
DRILLING METHOD: Auger - 4" diameter		BORING NO. 5
SAMPLING METHOD: Cuttings		SHEET 1 OF 1
		DRILLING START / FINISH
WATER LEVEL		
TIME		TIME 11:50 A.M. / TIME 11:55 A.M.
DATE		DATE 12/20 / DATE 12/20
CASING DEPTH		

SURFACE CONDITIONS: Snow dozed off

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO / SAMPLE DEPTH	BLOWS FT. SAMPLER	NUMBER OF BLOWS	DEPTH IN FEET	SOIL GRAPH
						0	
						1	
						2	
						3	
						4	
						5	
						6	
						7	
						8	
						9	
						10	
						11	
						12	
						13	
						14	
						15	
						16	
						17	
						18	
						19	
						20	

Reddish gravel (fine to coarse occasional boulders)

Met refusal at 2' hit boulder or bedrock.

DRILLING CONTR. Water Rights Sec. National Park Service, SSC

BY L. Sando DATE 12-20-67 CHK'D BY G. Witucki

623.1 (REV.)

LOCATION OF BORING

See Map Plat

Assume elev. of 0'
Axis of Canyon and
℄ of Emigrant C. Rd

DATUM ELEVATION 91'

JOB NO.	CLIENT	LOCATION
	DV-NM	Upper Emigrant Spr.

DRILLING METHOD	BORING NO.
Auger - 4" diameter	6
SAMPLING METHOD:	SHEET 1 OF 1
Cuttings	DRILLING START / FINISH

WATER LEVEL				
TIME				
DATE				
CASING DEPTH				

TIME: 12:00 Noon — TIME: 12:08 P.M.
DATE: 12/20 — DATE: 12/20

SURFACE CONDITIONS: Snow dozed off

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO / SAMPLE DEPTH	BLOWS/FT SAMPLER	NUMBER OF RINGS	DEPTH IN FEET	SOIL GRAPH
						0	
						1	
						2	
						3	
						4	
						5	
						6	
						7	
						8	
						9	
						0	
						1	
						2	
						3	
						4	
						5	
						6	
						7	
						8	
						9	
						0	

Reddish gravel (fine to coarse occasional boulder)

Met refusal at 5' either boulder or bedrock

DRILLING CONTR. Water Rights Sec. National Park Service, SSC

BY L. Sando DATE 12-20-67 CHK'D BY G. Witucki

625.1 (REV.)

LOCATION OF BORING

See Map Plat

Assume elev. of 0'
Axis of Canyon and
℄ of Emigrant C. Rd.

DATUM ELEVATION 74'

JOB NO.	CLIENT	LOCATION
	DV-NM	Upper Emigrant Spr.

DRILLING METHOD:	BORING NO.
Auger-4" diameter	7
SAMPLING METHOD:	SHEET 1 of 1
cuttings	DRILLING START / FINISH

WATER LEVEL	Signs of M. 6.5'	none		TIME 1:15 P.M. / TIME 1:25 P.M.
TIME	P.M.	A.M.		
DATE	12/20	12/21		DATE 12/20 / DATE 12/20
CASING DEPTH				

DRILLING CONTR. Water Rights Sec. National Park Service SSC

BY L. Sando DATE 12-20-67 CHK'D BY G. Witucki

SURFACE CONDITIONS: Dry-dozed out

SAMPLER TYPE	INCHES DRIVEN	INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO.	SAMPLE DEPTH	BLOWS/FT. SAMPLER	NUMBER OF BLOWS	DEPTH IN FEET	SOIL GRAPH	
								0		Sandy soil
								1		
								2		Grading reddish silty gravel occasional boulder
								3		
								4		
								5		grading sandy Signs of moisture at 6.5'
								6		
								7		greenish sandy gravel with clay (Maybe weathered bedrock) grading coarsen-gravel
								8		
								9		
								10		Met refusal at 9.5' probably bedrock.
								11		
								12		
								13		
								14		
								15		
								16		
								17		
								18		
								19		
								20		

625.1 (REV.)

LOCATION OF BORING

See Map Plat

Assume elev. of 0'
Axis of Canyon and
E of Emigrant C. Rd.

DATUM: ELEVATION 77'

JOB NO.	CLIENT	LOCATION
	DV-NM	Upper Emigrant Spr

DRILLING METHOD:	BORING NO.
Auger - 4" diameter	8
SAMPLING METHOD:	SHEET
Cuttings	1 of 1

	DRILLING START	DRILLING FINISH
WATER LEVEL		
TIME	TIME 1:00 P.M.	TIME 1:10 P.M.
DATE	DATE 12/20	DATE 12/20
CASING DEPTH		

SURFACE CONDITIONS: 3"-4" Snow

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO. / SAMPLE DEPTH	FLOWSAFE SAMPLER	NUMBER OF BLOWS	DEPTH IN FEET	SOIL GRAPH
						0	
						1	
						2	
						3	
						4	
						5	
						6	
						7	
						8	
						9	
						0	
						1	
						2	
						3	
						4	
						5	
						6	
						7	
						8	
						9	
						0	

Brown silty gravel
occasional boulder

Grading siltier

Drilling getting harder at 4.5' clayey silt

Met refusal at 5'- probably bedrock, silt above probably weathered bedrock.

DRILLING CONTR. Water Rights Sec. National Park Service, SSC

BY L. Sando DATE 12-20-67 CHK'D BY G. Witucki

LOCATION OF BORING

See Map Plat

Assume elev. of 0'
Axis of Canyon and
DATUM ℄ of Emigrant C. Rd. ELEVATION 73'

JOB NO.	CLIENT DV-NM	LOCATION Upper Emigrant Spr.
DRILLING METHOD: Auger - 4" diamet		BORING NO. 9
		SHEET 1 OF 1
SAMPLING METHOD: Cuttings		DRILLING START / FINISH

			START	FINISH
WATER LEVEL	12'	*12'	TIME 1:45 P.M.	TIME 2:05 P.M.
TIME	P.M.	A.M.		
DATE	12/20	12/21	DATE 12/20	DATE 12/20
CASING DEPTH		9'		

DRILLING CONTR. Water Rights Sec. National Park Service, SSC

BY L. Sando DATE 12-20-67 CHK'D BY G. Witucki

SURFACE CONDITIONS: Dry - dozed out

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO. / SAMPLE DEPTH	BLOWS/FT. SAMPLER	NUMBER OF RINGS	DEPTH IN FEET	SOIL GRAPH
						0	
						1	
						2	
						3	
						4	
						5	
						6	
						7	
						8	
						9	
						10	
						11	
						12	
						13	
						14	
						5	
						6	
						7	
						8	
						9	
						0	

Grading reddish silt gravel fine to coarse occasional boulder

Grading finer
Color change at 5' to greenish brown Silty clay

moisture at 8.5'

Met refusal at 14'
No standing water immediately after drilling - Standing water of 2' next day, before casing was set. Perforated casing was set to depth of 9' below surface

* Was unable to obtain accurate sounding after casing was set AS water level was stabilizing

635.1 (REV.)

LOCATION OF BORING

See Map Plat

Assume elev. of 0'
Axis of Canyon and
℄ of Emigrant C. Rd

JOB NO.	CLIENT	LOCATION
	DV-NM	Upper Emigrant Spr.

DRILLING METHOD	BORING NO.
Auger-4" diameter	10
SAMPLING METHOD: Cuttings	SHEET 1 of 1

		DRILLING START	DRILLING FINISH
WATER LEVEL			
TIME		TIME 9:30 A.M.	TIME 10:00 A.M.
DATE		DATE 12/20	DATE 12/20
CASING DEPTH			

DATUM: ℄ of Emigrant C. Rd ELEVATION: 73'

SURFACE CONDITIONS: Dry-dozed out.

DRILLING CONTR: Water Rights Sec. National Park Service, SSC

BY: L. Sando DATE 12-20-67 CHK'D BY G. Wituchi

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO. / SAMPLE DEPTH	MONITOR INSTALLED	NUMBER OF BLOWS	DEPTH IN FEET	SOIL GRADE
						0	
						1	
						2	
						3	
						4	
						5	
						6	
						7	
						8	
						9	
						0	
						1	
						2	
						3	
						4	
						5	
						6	
						7	
						8	
						9	
						0	

Reddish gravel fine to coarse occasional boulder

No signs of moisture

Met refusal probably a boulder

623-1 (REV.)

LOCATION OF BORING	JOB NO.	CLIENT	LOCATION
See Map Plat		DV-NM	Upper Emigrant

DRILLING METHOD: Auger-4" diameter

BORING NO. 11

SHEET 1 of 1

SAMPLING METHOD: Cuttings

			DRILLING START	DRILLING FINISH
WATER LEVEL	5′	5′	TIME 9:30 A.M.	TIME 10:00 A.M.
TIME	A.M.	A.M.	DATE 12/20	DATE 12/20
DATE	12/20	12/21		
CASING DEPTH		7.5′		

Assume elev. of 0′ Axis of Canyon and

DATUM ℄ of Emigrant C. Rd. ELEVATION 71′

SURFACE CONDITIONS: Snow on ground

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO / SAMPLE DEPTH	BLOWS/FT. SAMPLER	NUMBER OF RINGS	DEPTH IN FEET	SOIL GRAPH	
						0		
						1		
						2		Reddish silty gravel fine to coarse occasional boulder)
						3		
						4		Signs of Moisture at 5′
						5		grading siltier
						6		Color change, light yellow clayey silt
						7		(probably weathered bedrock)
						8		Met refusal at 7.5′ probably bedrock
						9		Immediately after drilling standing water at 2.5′ was measured - set perferated casing to depth 7.5′
						0		
						1		
						2		
						3		
						4		
						5		
						6		
						7		
						8		
						9		
						0		

DRILLING CONTR. Water Rights Sec. National Park Service, SSC

BY L. Sanda

DATE 12-20-67 CHK'D BY G. Witucki

LOCATION OF BORING

See Map Plat

Assume elev. of 0'
Axis of Canyon and
DATUM E. of Emigrant C. Rd. ELEVATION 64'

JOB NO.	CLIENT	LOCATION
	DV-NM	Upper Emigrant Spr

DRILLING METHOD: Auger - 4" diameter

BORING NO. 12

SHEET 1 OF 1

SAMPLING METHOD: Cuttings

DRILLING: START 12/20 TIME 3:05 P.M. — FINISH 12/20 TIME 3:15 P.M.

WATER LEVEL	3.8'	2'
TIME	P.M.	P.M.
DATE	12/20	12/21
CASING DEPTH		3.5'

DRILLING CONTR. Water Rights Sec. National Park Service, SSC

BY L. Sando DATE 12-20-67 CHK'D BY G. Witucki

SURFACE CONDITIONS: Snow on ground

CASING TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO. / SAMPLE DEPTH	BLOWS/FT. SAMPLER	NUMBER OF RUNS	DEPTH IN FEET	SOIL GRAPH
						0	
						1	
						2	
						3	
						4	
						5	
						6	
						7	
						8	
						9	
						10	
						11	
						12	
						13	
						14	
						15	
						16	
						17	
						18	
						19	
						20	

Reddish gravel (fine to coarse with occasional boulders)

Saturated at 3.5'

Met refusal at 4', probably a boulder

Immediately after drilling 0.2' of standing water - Set perforated casing depth 3.5'

GS-1 (REV.)

INDUSTRIAL TRUS-ACES FORMS & SYSTEMS INC — SAN JOSE

A 12

LOCATION OF BORING

See Map Plat

Assume elev. of 0' Axis of Canyon and ℄ of Emigrant C. Rd.

DATUM ELEVATION 61'

JOB NO.	CLIENT DV-NM	LOCATION Upper Emigrant Spr.
DRILLING METHOD: Auger - 4" diameter		BORING NO. 13
SAMPLING METHOD: Cuttings		SHEET 1 OF 1
		DRILLING START / FINISH
WATER LEVEL	7.2' / 6'	TIME 3:05 P.M. / 3:15 P.M.
TIME	P.M. / A.M.	
DATE	12/20 / 12/21	DATE 12/20 / 12/20
CASING DEPTH	/ 7'	

DRILLING CONTR. Water Rights Sec. National Park Service, SSC

BY L. Sando DATE 12-20-67 CHK'D BY G. Witucki

SURFACE CONDITIONS. Snow on ground

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO. / SAMPLE DEPTH	BLOWS/FT. SAMPLER	NUMBER OF RUNS	DEPTH IN FEET	SOIL GRAPH
						0	
						1	
						2	
						3	
						4	
						5	
						6	
						7	
						8	
						9	
						10	
						11	
						12	
						13	
						14	
						15	
						16	
						17	
						18	
						19	
						20	

Reddish gravel (fine to coarse with occasion' boulders)

Saturated at 3½'
grading siltier

green black silty shale

drilling harder at 6'

Met refusal at 7.5'

Immediately after drilling 0.3' Standing water was measured set perforated casing depth 7' after casing was set 1' of standing water was measured.

633.1 (REV.)

LOCATION OF BORING

See Map Plat

Assume elev. of 0'
Axis of Canyon and
℄ of Emigrant C. Rd

DATUM ℄ of Emigrant C. Rd ELEVATION 60'

JOB NO.	CLIENT: DV-NM	LOCATION: Upper Emigrant Sp
DRILLING METHOD: Auger-4" diameter		BORING NO. 14
SAMPLING METHOD: Cuttings		SHEET 1 OF 1
		DRILLING: START TIME 9:00 A.M. DATE 12/20; FINISH TIME 9:30 A.M. DATE 12/20

WATER LEVEL	0'	caved
TIME	A.M.	P.M.
DATE	12/20	12/21
CASING DEPTH		

DRILLING CONTR. Water Rights Sec. National Park Service SSC

BY L. Sando DATE 12-20-67 CHK'D BY G. Witucki

SURFACE CONDITIONS: Snow on ground

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO. / SAMPLE DEPTH	BLOWS/FT. SAMPLER	NUMBER OF RUNS	DEPTH IN FEET	SOIL GRAPH
						0	
						1	
						2	
						3	
						4	
						5	
						6	
						7	
						8	
						9	
						10	
						1	
						2	
						3	
						4	
						5	
						6	
						7	
						8	
						9	
						0	

Reddish gravel fine to coarse with occasional boulder

Signs of moisture 7.5'

grading siltier

Met refusal at 10'-probably bedrock

No standing water immediately after drilling

633.1 (REV.)

INDUSTRIAL FORMS & SYSTEMS INC.

A 14

LOCATION OF BORING

See Map Plat

Assume elev. of 0'
Axis of Canyon and
℄ of Emigrant C.Rd.

DATUM ELEVATION 60'

JOB NO.	CLIENT DV-NM	LOCATION Upper Emigrant Spr
DRILLING METHOD: Auger-4" diameter		BORING NO. 15
		SHEET 1 OF 1
SAMPLING METHOD: Cutting		DRILLING START / FINISH
WATER LEVEL	Signs at 6'	caved
TIME	P.M.	A.M.
DATE	12/20	12/21
CASING DEPTH		

DRILLING CONTR. Water Rights Sec. National Park Service SSC

BY L. Sando DATE 12-20-67 CHK'D BY G. Witucki

SURFACE CONDITIONS: Snow on ground

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO. / SAMPLE DEPTH	BLOWS/FT. SAMPLER	NUMBER OF BLOWS	DEPTH IN FEET	SOIL GRAPH
						0	
						1	
						2	
						3	
						4	
						5	
						6	
						7	
						8	
						9	
						10	
						11	
						12	
						13	
						14	
						15	
						16	
						17	
						18	
						19	
						20	

Silty gravel fine to coarse occasional boulder

Reddish brown silty gravel (occasional boulder)

Signs of moisture at 6'

Met refusal at 6' possible bedrock

No standing water immediately after drilling

625.1 (REV.)

LOCATION OF BORING

See Map Plat

Assume elev. of 0'
Axis of Canyon and
℄ of Emigrant C. Rd.

DATUM ELEVATION 59'

JOB NO. | CLIENT DV-NM | LOCATION Upper Emigrant Spr.

DRILLING METHOD: Auger - 4" diameter

BORING NO. 16

SHEET 1 of 1

SAMPLING METHOD: Cuttings

	STARTED	FINISHED
WATER LEVEL		
TIME	2:35 P.M.	3:00 P.M.
DATE	12/20	12/20
CASING DEPTH		

DRILLING CONTR. Water Rights Sec. National Park Service, SSC

BY L. Sando DATE 12-20-67 CHK'D BY G. Witucki

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO. / SAMPLE DEPTH	BLOWS/FT. SAMPLER	NUMBER OF BLOWS	DEPTH IN FEET	SOIL GRAPH
						0	
						1	
						2	
						3	
						4	
						5	
						6	
						7	
						8	
						9	
						0	
						1	
						2	
						3	
						4	
						5	
						6	
						7	
						8	
						9	
						0	

SURFACE CONDITIONS: Snow on ground

Reddish gravel (fine to coarse occasional boulder)

Met refusal - probably bedrock.

523.1 (REV.)

INDUSTRIAL FORMS & SYSTEMS, INC.

A 16

LOCATION OF BORING

See Map Plat

Assumed elev. of 0'
Axis of Canyon and
℄ of Emigrant C. Rd

DATUM ELEVATION 55'

JOB NO.	CLIENT DV-NM	LOCATION Upper Emigrant Spr.
DRILLING METHOD: Auger-4" diameter		BORING NO 17
SAMPLING METHOD: Cuttings		SHEET 1 OF 1

				DRILLING START	DRILLING FINISH
WATER LEVEL	2'	2'			
TIME	P.M.	A.M.		TIME 3:24 P.M.	TIME 3:30 P.M.
DATE	12-20	12-21		DATE 12/20	DATE 12/20
CASING DEPTH					

DRILLING CONTR. Water Rights Sec. National Park Service SSC

BY L. Sando DATE 12-20-67 CHK'D BY G. Witucki

SURFACE CONDITIONS: In narrow run off

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO / SAMPLE DEPTH	BLOWS/FT. SAMPLER	NUMBER OF RUNS	DEPTH IN FEET	SOIL GRAPH
						0	
						1	
						2	
						3	
						4	
						5	
						6	
						7	
						8	
						9	
						10	
						11	
						12	
						13	
						14	
						15	
						16	
						17	
						18	
						19	
						20	

Saturated at 1'

Reddish brown silty gravel fine to coarse occasional boulder

Met refusal at 4', probably bedrock

2' of standing water after drilling

GS-1 (REV.)

LOCATION OF BORING

See Map Plat

Assume elev. of 0'
Axis of Canyon and
Datum ℄ of Emigrant C. Rd. ELEVATION 54'

JOB NO.	CLIENT DV-NM	LOCATION Upper Emigrant Spr
DRILLING METHOD: Auger-4" diameter		BORING NO. 18
SAMPLING METHOD: Cuttings		SHEET 1 OF 1
		DRILLING START / FINISH
WATER LEVEL	1.5' / 1.5'	
TIME	P.M. / A.M.	TIME 3:30 P.M. / 4:00 P.M.
DATE	12-20 / 12-21	DATE 12/20 / DATE 12/20
CASING DEPTH		

DRILLING CONTR. Water Rights Serv. National Park Service SSC

BY L. Sando DATE 12-20-67 CHK'D BY G. Witucki

SURFACE CONDITIONS: In narrow run off

EXPLORATION TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO / SAMPLE DEPTH	BLOWS/FT. FALL/LB	NUMBER OF RUNS	DEPTH IN FEET	SOIL GRAPH
						0	
						1	
						2	
						3	
						4	
						5	
						6	
						7	
						8	
						9	
						10	
						11	
						12	
						13	
						14	
						15	
						16	
						17	
						18	
						19	
						20	

Saturated at 0.5'

Reddish gravel (fine to coarse with occasional boulders)

Met refusal at 3' probably bedrock

1.5' of standing water immediately After drilling

625.1 (REV.)

LOCATION OF BORING

See Map Plat

Assumed elev. of 0' Axis of Canyon and ℄ of Emigrant C. Rd.

DATUM ELEVATION 45'

JOB NO.	CLIENT	LOCATION
	DV-NM	Upper Emigrant Spr

DRILLING METHOD	BORING NO.
Auger-4" diameter	19
SAMPLING METHOD:	SHEET
Cuttings	1 of 1
	DRILLING START / FINISH

					TIME	TIME
WATER LEVEL	2'	2'			3:30 P.M.	4:00 P.M.
TIME						
DATE	12/20	12/21			DATE 12/20	DATE 12/20
CASING DEPTH						

DRILLING CONTR. Water Rights Sec. National Park Service, SSC

BY L. Sando DATE 12-20-67 CHK'D BY G. Witucki

SURFACE CONDITIONS: Narrow run off surface very wet

CAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO / SAMPLE DEPTH	BLOWS/FT. HAMMER	NUMBER OF RUNS	DEPTH IN FEET	SOIL GRAPH
						0	
						1	
						2	
						3	
						4	
						5	
						6	
						7	
						8	
						9	
						0	
						1	
						2	
						3	
						4	
						5	
						6	
						7	
						8	
						9	
						0	

Reddish gravel fine to coarse with boulders

Met refusal, bedrock

Saturated surface down

635.1 (REV.)

LOCATION OF BORING

See Map Plat

Assume elev. of 0' ℄ of Emigrant Canyon Rd. and axis of Canyon

DATUM ELEVATION 61'

JOB NO.	CLIENT	LOCATION
	DV-NM	Lower Emigrant Spr.

DRILLING METHOD: pneumatic-type drill 2 3/4" bit	BORING NO. 1
SAMPLING METHOD:	SHEET 1 OF 1
	DRILLING START / FINISH
WATER LEVEL	TIME A.M. / A.M.
TIME	
DATE	DATE 12/21 / 12/21
CASING DEPTH	

DRILLING CONTR. Water Rights Sec. National Park Service, SSC

BY L. Sando DATE 12-21-67 CHK'D BY G. Witucki

SURFACE CONDITIONS: Snow on ground

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO / SAMPLE DEPTH	BLOWS/FT. HAMMER WT.	NUMBER OF RUNS	DEPTH IN FEET	SOIL GRAPH
						0	
						1	
						2	
						3	
						4	
						5	
						6	
						7	
						8	
						9	
						10	
						11	
						12	
						13	
						14	
						15	
						16	
						17	
						18	
						19	
						20	

Grey gravel

Met refusal bedrock green felsite body

LOCATION OF BORING
This boring is approximately 25' lower in elev. than the orangeburg Pipe up at the gathering system. Drilled at an angle of about 45°

See Map Plat

Assume elev. of 0' ℄ of Emigrant Canyon Rd.

DATUM and axis of Canyon ELEVATION 61'

JOB NO.	CLIENT	LOCATION
	DV-NM	Lower Emigrant Spr.

DRILLING METHOD: Pneumatic Type drill 2 3/4" bit

SAMPLING METHOD:

BORING NO. 2

SHEET 1 OF 1

					DRILLING START	DRILLING FINISH
WATER LEVEL					TIME A.M.	TIME P.M.
TIME						
DATE					DATE 12/21	DATE 12/21
CASING DEPTH						

DRILLING CONTR. Water Rights Sec. National Park Service, SSC

BY L. Sando DATE 12-21-67 CHK'D BY G. Witucki

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO / SAMPLE DEPTH	BLOWS/FT. SAMPLER	NO. DIM OF RINGS	DEPTH IN FEET	SOIL GRAPH
						0	
						1	
						2	
						3	
						4	
						5	
						6	
						7	
						8	
						9	
						10	
						11	
						12	
						13	
						14	
						15	
						16	
						17	
						18	
						19	
						20	

Slant Depth

SURFACE CONDITIONS: Snow on ground-site is located in an eroded drainage ditch above the old mine shafe opening.

Green clayey silt (Probably weathered green filsite)

Encountered water flow at 3.5' stopped at 4' at 11:45 A.M. with 6" of water at the bottom by 12:00 noon boring filled to top, grading coaser.
Encountered water flow at 6' drilling got harder
Green clayey gravel

Met refusal at 9'

Remark:
Water appears to be flowing in the boring in small streams at slant depth of 3.5' and 6' at a rate of approx. 1/10 G.P.M., at the end of 4 hours the boring filled several inches from the surface and appeared static.